Do Now

The Quotient Rule

$$\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{g(x)f'(x) - f(x)g'(x)}{[g(x)]^2}$$

Find an equation of the tangent line to the graph of *f* at the point $(-8, 5)$

$$f(x) = \frac{x}{2x+4}$$

$$\frac{2x+4(1) - x(2)}{(2x+4)^2} \rightarrow \frac{\cancel{2x}+4-\cancel{2x}}{(2x+4)^2} \rightarrow \frac{4}{(2x+4)^2}$$

$$\frac{4}{(2(-8)+4)^2} \rightarrow \frac{4}{(-12)^2} \rightarrow \frac{4}{144}$$

$$y-5 = \frac{4}{144}(x+8)$$

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Given the differentiable functions, $f(x)$ and $g(x)$. Using the table below,

x	$f(x)$	$g(x)$	$f'(x)$	$g'(x)$
6	-3	7	2	-4

A.) Find the equation of the line tangent to $g(x)$ at $x = 6$.

$m = -4$

$(6, 7)$ $\quad y - 7 = -4(x-6)$

B.) Find the equation of the line tangent to $f(x)$ at $x = 6$.

$(6, -3)$ $\quad m = 2$

$y + 3 = 2(x-6)$

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EX #6: Using the Constant Multiple Rule to Rewrite

Function	Rewrite	Differentiate	Simplify
$y=\frac{x^2-4x}{8}$	$\frac{1}{8}x^2-\frac{1}{2}x$	$\frac{1}{4}x-\frac{1}{2}$	$\frac{x}{4}-\frac{1}{2}\to\frac{x}{4}-\frac{2}{4}$ $\frac{x-2}{4}$
$y=\frac{3x^3}{5}$	$\frac{3}{5}x^3$	$\frac{9}{5}x^2$	$\frac{9x^2}{5}$
$y=\frac{6x^{\frac{5}{2}}}{x}\to 6x^{5/2-1}$	$6x^{3/2}$	$9x^{\frac{1}{2}}$	$9\sqrt{x}$
$y=\frac{6x^4+x^3-2x}{\sqrt{x}}$ $y=\frac{6x^4}{x^{\frac{1}{2}}}+\frac{x^3}{x^{\frac{1}{2}}}-\frac{2x}{x^{\frac{1}{2}}}$	$6x^{7/2}+x^{5/2}-2x^{\frac{1}{2}}$	$21x^{5/2}+\frac{5}{2}x^{3/2}-x^{-\frac{1}{2}}$ $21\sqrt{x^5}+\frac{5}{2}\sqrt{x^3}-\frac{1}{\sqrt{x}}$	

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Higher Order Derivatives

Did you realize that it is possible to take the derivative of a derivative? We will need this ability in the study of particle motion and objects in motion, especially related to physics in the near future.

$s(t)$	**Position function**
$v(t)=s'(t)$	**Velocity function**
$a(t)=v'(t)=s''(t)$	**Acceleration function**

First derivative:	y'	$f'(x)$	$\frac{dy}{dx}$	$\frac{d}{dx}[f(x)]$	$D_x[y]$
Second derivative:	y''	$f''(x)$	$\frac{d^2y}{dx^2}$	$\frac{d^2}{dx^2}[f(x)]$	$D_x^2[y]$
Third derivative:	y'''	$f'''(x)$	$\frac{d^3y}{dx^3}$	$\frac{d^3}{dx^3}[f(x)]$	$D_x^3[y]$
Fourth derivative:	$y^{(4)}$	$f^{(4)}(x)$	$\frac{d^4y}{dx^4}$	$\frac{d^4}{dx^4}[f(x)]$	$D_x^4[y]$

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EX #7: For each of the following, find the second derivative.

A.) $f(x)=\frac{3}{2}x^3+5x^2-6x+1$

$f'(x)=\frac{9}{2}x^2+10x-6$

$f''(x)=9x+10$

B.) $g(x)=\frac{x^2-4x-5}{x}$

$g(x)=x^{-4}-5x^{-1}$

$g'(x)=1+5x^{-2}$

$g''(x)=-10x^{-3}$

$\frac{x(2x-4)-(x^2-4x-5(1)}{x^2}$

$\frac{2x^2-4x-x^2+4x+5}{x^2}$

$\frac{x^2+5}{x^2} \rightarrow \frac{x^2(2x)-(x^2+5)(2x)}{x^4}$

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C.) $y=\frac{x}{x+2}$

$y'=\frac{(x+2)(1)-x(1)}{(x+2)^2}$

$y'=\frac{\cancel{x}+2-\cancel{x}}{(x+2)^2} \rightarrow \frac{2}{(x+2)^2}$

$\frac{2}{x^2+4x+4} \rightarrow$ We haven't learned chain rule yet

$y'' \rightarrow \frac{\cancel{(x^2+4x+4)(0)}-2(2x+4)}{(x+2)^4}$

$y''=\frac{-2(2x+4)}{(x+2)^4} \rightarrow \frac{-4\cancel{(x+2)}}{(x+2)^{\cancel{4}\,3}}$

$\rightarrow \frac{-4}{(x+2)^3}$

D.) $f(x)=4\sqrt{x}-\frac{6}{\sqrt{x}}$

$f(x)=4x^{\frac{1}{2}}-6x^{-\frac{1}{2}}$

$f'(x)=2x^{-\frac{1}{2}}+3x^{-3/2}$

$f''(x)=-x^{-3/2}-\frac{9}{2}x^{-5/2}$

$=\frac{-1}{\sqrt{x^3}}-\frac{9}{2\sqrt{x^5}}$

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